An Evaluation of Automatic Terminal Information Service (ATIS) Flight Deck Display Presentation Options

Albert J. Rehmann

April 1994

DOT/FAA/CT-TN93/25

US Department of Transportation
Federal Aviation Administration

Technical Center
Atlantic City International Airport, N.J. 08405

technical note technical note

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the objective of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN93/25		

4. Title and Subtitle AN EVALUATION OF AUTOMATIC TERMINAL INFORMATION SERVICE (ATIS) FLIGHT DECK DISPLAY PRESENTATION OPTIONS	5. Report Date April 1994 6. Performing Organization Code ACD-320
7. Author's Albert J. Rehmann	8. Performing Organization Report No. DOT/FAA/CT-TN93/25
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. T2003C
12. Sponsoring Agency Name and Address	13. Type or Report and Period Covered Technical Note December 1992 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This document describes the first of three studies relating to human factors aspects in the flight deck display of Automatic Terminal Information Service (ATIS). This research is being conducted by the Federal Aviation Administration (FAA) Technical Center. The first part-task study examined basic format design variables. Its purpose was to (1) begin addressing flight deck design issues pertinent to the design of the tower ATIS workstation and, (2) collect data relevant to standard and certification groups within the FAA. Future studies in an FAA Technical Center high-fidelity mock-up and various aircraft simulators will examine full mission issues, such as procedures, equipment mechanization, and automation.

17. Key Words	18. Distribution Statement
Avionics Data Link Human Factors Automatic Terminal Information Service (ATIS) Aircraft Communications Addressing and Reporting System (ACARS)	This documentation is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Form DOT F 1700.7 (18_72) Reproduction of completed page authorized

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) and Aeronautical Radio Inc. (ARINC) are working a joint program to develop a capability to transmit Automatic Terminal Information Service (ATIS) information over the Aircraft Communications Addressing and Reporting System (ACARS) very high frequency (VHF) Data Link, which was developed, and is managed by ARINC.

This document describes the first study of three by the FAA Technical Center of human factors aspects in the flight deck display of ATIS. This first part-task study examined basic format design variables. The purpose of this research was to 1) begin addressing flight deck issues pertinent to the design of the air traffic control (ATC) tower ATIS work station and, 2) collect data relative to standard and certification groups within the FAA. Future studies in an FAA Technical Center high fidelity mockup, and various aircraft simulators, will examine full mission issues such as procedures, equipment mechanization, and automation.

The research question for this phase of testing is as follows: What is the best format, from a pilot's perspective, to present ATIS information in the flight deck to facilitate rapid and accurate information transfer? A total of 59 pilots assessed ATIS designs, as presented on two common ACARS output devices. The test involved assessing the time required to retrieve information from the various ATIS design options, and the frequency of retrieval errors. The pilots also completed a questionnaire at the end of formal testing.

The variables being tested, in this first phase, include language type, data structure, and text case. Other design variables were considered, but were not selected, since they were expected to have little or no impact initially. Human-computer interface literature was reviewed for supporting data in selecting the most critical variables.

The time and errors data were reduced, and descriptive statistics were generated; inferential statistics on the time data were generated. The subjective data were summarized and presented. Three design recommendations were made, relative to the ATIS ACARS flight deck interface design. In summary, upper case, categorized teletype should be used on the flight deck, for the display of ATIS information.

INTRODUCTION

Automated Terminal Information Service (ATIS) flight deck-oriented research will be conducted in three phases. This report describes the first phase, which was a part-task oriented study of basic design variables. The objective of this research effort was to have airline pilots formally comment on human factors issues pertinent to the flight deck display of ATIS information. Preliminary design data can then be provided to workstation system designers for their use in the initial maintenance update by Aeronautical Radio, Inc. (ARINC).

Phase II will be the field studies at Pittsburgh and Baltimore. Phase III will consist of evaluation in the Federal Aviation Administration (FAA) Technical Center's Reconfigurable Cockpit Simulator (RCS) mockup, and high fidelity simulators, in an operational evaluation-type setting. Objective data, and more complex issues, will be addressed in full mission contexts.

PURPOSE.

The purpose of the study was to begin addressing flight deck design issues which might impact the design of the tower work station, which will be used to create ATIS messages. The study also examined areas of concern of standards and certification personnel within the FAA. The study has provided a significant data base of subjective comments from pilots on ATIS display design options. This data will allow researchers to scope future mockup and simulation studies, which will assist in the development of flight deck procedures.

BACKGROUND.

The FAA Data Link Applications Office has been working with ARINC to develop a method of delivering ATIS messages via a very high frequency (VHF) Data Link to the flight deck of selected air carriers, at selected airports within the USA. The VHF Data Link is the Aircraft Communications Addressing and Reporting System (ACARS), developed and managed by ARINC.

Engineering tests by ARINC and USAir were conducted, in the period of December 1991 to April 1992. In this principally non-human factors-related research, a number of comments pertinent to the cockpit ATIS presentation were made by pilots from USAir; the interface design used in these tests was straight English (ENG) text in upper case. Comments were received concerning using ENG, as opposed to standard National Weather Service acronyms and abbreviations, or radio teletype (RTTY). These comments were considered, along with other human factors principles, in the development of this part-task test.

A second evaluation by air traffic controllers was conducted in February 1992. A follow-on test was conducted in June, 1992, by ARINC. The June test allowed air traffic control (ATC) tower personnel to critique the ATIS work station on which the ATIS messages will be input for dissemination over ACARS. Flight deck-oriented evaluations were not conducted during this test.

Field testing of the ACARS ATIS system began in October 1992. The first two airports to offer the ACARS ATIS capability were Pittsburgh and Baltimore-Washington; workstations will be added at other airports later.

The presentation format for the flight deck (upper-case ENG) has been set for the first version of the operating workstation software; any changes to that format would have to be minor. Other changes will become possible during the standard maintenance update, which will occur approximately one year after implementation.

RESEARCH QUESTION.

The research question generated for this evaluation was as follows: "What is the best format, from a pilot's perspective, to present ATIS information in the flight deck, to facilitate rapid and accurate information transfer?"

DISCUSSION

SUBJECT PILOTS.

Volunteer subject pilots were obtained from various airlines, including USAir, Delta, American, and United. The pilots (captains and/or first officers) had experience in a number of aircraft types, B-727, B-737, B-747, B-757/767, F-100. A complete listing of aircraft experience is contained in appendix E.

Although a total of 59 pilots participated, a complete data package (objective and subjective) was obtained on only 49, since some pilots were only able to participate in an abbreviated interview. Basic personal data (name, address, and phone) were gathered from some, along with permission to contact them at future dates, if necessary. Anonymity was guaranteed to all participating pilots.

FACILITY AND APPARATUS.

A PC-driven Teledyne Interactive Display Unit (IDU) was used to present ATIS messages. This IDU represents the actual hardware used on USAir for the ACARS; it is somewhat similar to the system used on Delta aircraft for the ACARS (Delta uses the Collins IDU). The Teledyne IDU displays 11 lines of data and 21 characters per line.

Some airlines, for example, American, use printers as the output device for the ACARS. These thermal-type printers use 4.5 inch wide paper, capable of about 40 characters per line; length is limited by the link, and the sender. Printout versions of the ATIS messages were generated for those crews whose airline uses a printer as the ACARS display.

ORIENTATION.

The nature of this effort precluded the need for any elaborate equipment training. While all pilots were familiar with the concept of ATIS, an orientation into the concept of ACARS ATIS was provided. Further, an orientation period, prior to actual testing, was conducted to discuss the purpose and background of the study, and to answer the pilots' questions. Since the display designs were the concern, the ATIS request process was eliminated. That is, the pilot did not have "button pushing" tasks; the display of ATIS was experimentally controlled. It was emphasized to the volunteers that they were evaluating the display design option - in no way were their flying skills being tested.

SYSTEM DESIGN AND INDEPENDENT VARIABLES.

The content of the ATIS message is defined in the Airmen's Information Manual and the Pilot's Reference to ATC Procedures and Phraseology. It is noted that ATIS is considered non-control, essential, but routine, information for the pilot. Pilots are required to obtain the ATIS early, and provide the ATIS information code to ATC, upon initial contact.

The independent variables selected for this study were language, data structure, and case. The language variable included ENG, RTTY, and an intermediate or compromise (COMP) translation. The data structure variable included the condition where all data are clustered (CLUS) together, and the ATIS is divided into three distinct categories (CAT) (header information, weather, and Notices to Airmen (NOTAM)/remarks). The case variable included all upper and mixed case.

The tested designs are shown in appendix A (Teledyne IDU version only); the content of the printed version was the same, only the width of text differs. Six departure and six arrival-oriented messages were generated for this study.

These variables were selected for study, because it was expected that they would have the greatest initial impact on the design. Other variables of interest exist, for example, highlighting, but were eliminated from initial consideration in order to keep the testing manageable. Additionally, the display and printouts were capable of supporting the potential conditions of these variables.

A number of documents were reviewed to aid in the design of potential display formats. The document by Smith and Mosier (1986) entitled "Guidelines for Designing User Interface Software" was a primary source. Other documents, as referenced in Smith and Mosier, were reviewed, as well.

The language variable was examined in the context of Smith and Mosier guidelines calling for 1) minimal use of abbreviations, 2) use of common abbreviations, 3) simple abbreviation rules, and 4) distinctive abbreviations (sections 2.1.16 through 2.1.19). They recommend that complete words be displayed, in preference to abbreviations. It is noted, however, that when abbreviations are used, choose those that are commonly recognized, and are not uncommon or ambiguous. Abbreviation, by truncation, is generally considered the best method. Finally, ensure that abbreviations are distinctive, so that different words are distinguishable.

The case variable was discussed in Smith and Mosier, section 2.1.6. It is recommended that one display continuous text conventionally in mixed case. The data structure variable was selected after providing a demonstration of the Teledyne IDU, and a preliminary ATIS design to a group of professional pilots, and receiving a number of excellent comments. This structure variable represents only one of many that were recommended; the others will be considered in future studies.

PROCEDURE.

Each volunteer pilot was briefed on the purpose of the study, and the general protocol to be followed. Any questions were answered before starting the test.

A pilot was asked to comment only on the output mode (display or printout) he or she would potentially see in their aircraft. Before starting the test, the pilot was shown (on paper) a sample of each format design to be seen in the testing phase. An experimental trial consisted of the events described on the following pages.

The experimenter presented a brief setup scenario for each trial, then told the pilot what pieces of data to pick out from the ATIS message about to be presented. The pilot was asked to read off the requested data as rapidly and accurately as possible. The experimenter then turned on the IDU ATIS message prompt; the pilot touched the flashing prompt to display the ATIS and start the timer. When the pilot finished reading the ATIS, he or she touched the return prompt (<RTN>) on the IDU to remove the ATIS from view and stop the timer. The experimenter wrote the responses on a test sheet. All other pertinent comments made at any time during the session were noted.

The initial procedure for the printer trials was the same, except for the initial presentation of the ATIS. The printed ATIS was presented to the pilot in a series of notebook pages, and a manual timer was used.

An example of a setup scenario and question is as follows: "This next trial provides the arrival ATIS for Dayton International, and you are to determine the ceiling, altimeter, and landing runway." Note, that in all trials, three specific pieces of data from each ATIS were to be retrieved by the pilot. After completing all 12 trials, the pilot completed the written questionnaire, and was then released. An experimenter's checklist was used to help ensure each pilot received the same briefing. The setup scenario, question, and answer for each of the design options, is defined in appendix B.

The potential problems of this part-task study concerning minimal task loading, individual differences in reading rates, motivation, and the depth of the reader's review of the messages, are noted and accepted. Nonetheless, it is proposed that a relative measure of "readability" for each design option was obtained. Response errors were defined as incomplete, incorrect, or no responses.

HYPOTHESIS.

The following hypothesis was offered, in accordance with the guidelines discussed in Smith and Mosier, and the comments received from pilots in initial demonstrations of the system. The COMP language, and the mixed-case text, in conjunction with the CAT data, should result in the fastest read time, and the fewest errors of all other conditions.

EXPERIMENTAL DESIGN.

A three-factor, repeated-measures design was employed. Three levels of language, and two levels of data structure and case, were examined. All twelve design options were randomly presented to each pilot.

DATA REDUCTION AND ANALYSIS.

The objective data (time and errors) were reduced, and descriptive statistics were calculated for IDU and printer data, and an analysis of variance (ANOVA). An insufficient sample size was obtained to perform a printer-oriented ANOVA. The questionnaire data were summarized and presented. All pertinent comments made during testing were presented. Data were not traceable to a specific pilot.

RESULTS

This section will describe, in detail, the statistical analyses performed on the data including time, errors, and subjective. A brief and non-statistical discussion of these results is presented in the section of this report entitled "Subjective Data"; conclusions and recommendations will be outlined in the section of this report entitled "Discussions and Recommendations."

OBJECTIVE TIME DATA.

IDU DATA. The mean time by design option, obtained from the 45 IDU pilots, is shown in figure 1. Table 1 shows the mean time data for each option, and selected conditions. The ANOVA source table is shown in table 2. The overall ANOVA resulted in a significant 3-way interaction ($F=3.32$, $p=.041$)[1] between the three factors (case, language and structure) of study. As a guide, graphical plots of the data were constructed to help visualize the effects. More specifically, figures 2 through 4 depict the main effects, and figures 5 through 7 depict the possible two-way interactions from the overall ANOVA (table 2).

The main effects of language ($F=29.47$, $p=.000$) and case ($F=25.81$, $p=.000$), and the interaction effects for case by language ($F=6.25$, $p=.003$) and structure by language ($F=26.69$, $p=.000$) can not be interpreted unambiguously because of the presence of the 3-way interaction. In fact, the main and two-way interaction effects should be ignored in the final interpretation of the results. Therefore, a plot was constructed to assess the dissimilar effects for the case by language interaction under each level of the structure variable (figure 8). Immediate reaction to the figures is the dissimilar effects, most notably, the apparent downward trend observed for pilot response times across levels of language for CAT design options, as opposed to the level/slightly-upward trend observed for CLUS-design options. Specifically, there is a 32 percent decrease in IDU mean time to respond between ENG-CAT (25.53 seconds) and COMP-CAT (17.31 seconds) options, as opposed to a 13 percent decrease between ENG-CLUS (20.35 seconds) and COMP-CLUS options (17.74 seconds).

Without exception, the two-way interactions can be explained. One can generalize that the case by language (figure 7) interaction is a result of no significant difference in IDU response time between upper-RTTY and mixed-RTTY, no matter what structure cues are

---

[1] The terms F and p refer to variables used in tests of statistical significance indicating the probability that an observed statistic was due to chance factors. Having a sufficiently low probability would be a good indicator that the observed phenomena/test condition is not due to chance factors.

TABLE 1. MEAN TIME DATA BY SELECTED CONDITIONS (SECONDS)

OPTION	TIME	OPTION	TIME
1	27.92	7	23.13
2	21.32	8	19.38
3	19.53	9	15.09
4	20.43	10	15.05
5	15.8	11	17.12
6	23.02	12	20.81

UPPER	21.34	UPPER ENG	24.62	ENG CAT	25.53	CAT UPPER	21.10
MIXED	18.43	UPPER COMP	19.98	ENG CLUS	20.35	CLUS UPPER	21.6
		UPPER RTTY	19.43			CAT MIXED	18.45
ENG	22.34			COMP CAT	17.31	CLUS MIXED	18.4
COMP	17.53	MIXED ENG	21.25	COMP CLUS	17.74		
RTTY	19.20	MIXED COMP	15.07				
		MIXED RTTY	18.97	RTTY CAT	16.48		
CAT	19.77			RTTY CLUS	21.91		
CLUS	20.00						

DESIGN OPTION NUMBER LEGEND

1. ENG, CAT, UPPER
2. ENG, CLUS, UPPER
3. COMP, CAT, UPPER
4. COMP, CLUS, UPPER
5. RTTY, CAT, UPPER
6. RTTY, CLUS, UPPER
7. ENG, CAT, MIXED
8. ENG, CLUS, MIXED
9. COMP, CAT, MIXED
10. COMP, CLUS, MIXED
11. RTTY, CAT, MIXED
12. RTTY, CLUS, MIXED

TABLE 2. TIME ANOVA SOURCE TABLE

BOLD SIGNIFIES SIGNIFICANT MAIN EFFECTS OR INTERACTIONS

Source / Variations	SS	DF	MS	F	Sig of F
CASE	1145.81	1	1145.81	25.81	.000
LANGUAGE	2765.37	2	1382.69	29.47	.000
STRUCTURE	6.98	1	6.98	.18	.672
CASE by LANGUAGE	459.94	2	229.97	6.25	.003
CASE by STRUC	9.39	1	9.39	.22	.640
LANGUAGE by STRUCTURE	2533.40	2	1266.70	26.69	.000
CASE by LANGUAGE by STRUC	228.02	2	114.01	3.32	.041

available. Furthermore, the structure-by-language (figure 6) interaction is a result of the reverse effect of structure cues on ENG and RTTY options; categorization increased pilot response times by 25 percent on ENG options and decreased response times by 25 percent on RTTY options. An explanation for this reverse trend can be derived from the design nature of ENG options, which require more pages (CAT) to display all the ATIS information.

This difference in ENG presentations may have biased all response time results upwards, as compared to the other language options that only required a single page for display. While this could be seen as a confound in the experiment, it may be of practical concern, given the restrictions inherent in current display technologies. More display pages may be required for presentation of ATIS information in the ENG format, resulting in slower reading times. One can also argue that the behavior observed for RTTY options is a direct result of prior experience with acronyms/abbreviations typically used in weather briefings.

Given the significance of the three-way interactions in figures 8 and 9, other main and two-way effects should not be interpreted independently. However, the results shown in figures 8 and 9 have not been statistically tested, and it is not certain that all observed differences are due to the effects of the independent variables, as opposed to random variation in the data.

The graphs indicate that the following distinctions can be made between combinations of the three independent variables:

a. ENG-upper-CAT is slower than all other Eng options.

b. Mixed (square symbols) is faster, in general, and faster than upper, in the COMP option.

c. CLUS is slower than CAT in RTTY.

d. COMP-mixed-CAT, and RTTY-mixed-CAT or RTTY-upper-CAT, are fastest.

PRINTER DATA. The mean time by design option, obtained from the four printer pilots, is shown in figure 10. No further detailed analyses were conducted on this data due to the small sample size.

OBJECTIVE ERROR DATA.

The responses received from the pilots were checked for errors. An error was operationally defined as an incomplete answer, an incorrect answer, or a no response. The overall error count was 87 (IDU/Printer: 72/15), and distributed among the design options, as depicted in figure 11, and listed in table 3. The errors are categorized as follows: incorrect responses (W) totaled 19, incomplete responses (I) totaled 62, and, in 6 cases, no response was received.

A total of 49 pilots (IDU/Printer: 45/4) evaluated 12 options, each with 3 pieces of data, for a total of 1764 responses. The resulting human-error rate was 4.9 percent; by IDU and printer groups, respectively, the percentages were 4.4 percent and 10.4

TABLE 3. OVERALL ERROR DATA BY SELECTED CONDITIONS (COUNT)

OPTION	ERRORS	OPTION	ERRORS
1	24	7	9
2	2	8	3
3	14	9	1
4	10	10	0
5	8	11	2
6	13	12	1

UPPER	71	UPPER ENG	26	ENG CAT	33	CAT UPPER	46
MIXED	16	UPPER COMP	24	ENG CLUS	5	CLUS UPPER	25
		UPPER RTTY	21			CAT MIXED	12
ENG	38			COMP CAT	15	CLUS MIXED	4
COMP	25	MIXED ENG	12	COMP CLUS	10		
RTTY	24	MIXED COMP	1				
		MIXED RTTY	3	RTTY CAT	10		
CAT	58			RTTY CLUS	14		
CLUS	29						

DESIGN OPTION NUMBER LEGEND

1. ENG, CAT, UPPER
2. ENG, CLUS, UPPER
3. COMP, CAT, UPPER
4. COMP, CLUS, UPPER
5. RTTY, CAT, UPPER
6. RTTY, CLUS, UPPER
7. ENG, CAT, MIXED
8. ENG, CLUS, MIXED
9. COMP, CAT, MIXED
10. COMP, CLUS, MIXED
11. RTTY, CAT, MIXED
12. RTTY, CLUS, MIXED

percent. Emphasis is placed on human-error rate to clearly distinguish it from the ACARS link-error rates, which are significantly less. Appendix D contains a chart listing the error type by pilot and design option.

The errors ANOVA source table is shown in table 4. The overall ANOVA resulted in a significant 3-way interaction ($F=8.46$, $p=.000$) between the three factors (case, language and structure) of study. As a guide, graphical plots of the data were constructed to help visualize the effects. Specifically, figures 12 through 14 depict the main effects, and figures 15 through 17 depict the possible two-way interactions from the overall ANOVA (table 4).

The main effects of language ($F=3.29$, $p=.042$), case ($F=33.72$, $p=.000$), structure ($F=11.45$, $p=.002$), and the interaction effect for language by structure ($F=15.62$, $p=.000$), can not be interpreted unambiguously because of the presence of the 3-way interaction. In fact, the main and two-way interaction effects should be ignored in the final interpretation of the results. Therefore, plots were

TABLE 4. ERRORS ANOVA SOURCE TABLE

BOLD SIGNIFIES SIGNIFICANT MAIN EFFECTS OR INTERACTIONS

Source / Variation	SS	DF	MS	F	Sig of F
CASE	4.27	1	4.27	33.72	.000
LANGUAGE	.54	2	.27	3.29	.042
STRUCTURE	1.07	1	1.07	11.45	.002
CASE by LANGUAGE	.08	2	.04	.48	.619
CASE by STRUCTURE	.27	1	.27	1.79	.188
LANGUAGE by STRUCTURE	3.10	2	1.55	15.62	.000
CASE by LANGUAGE by STRUCTURE	1.48	2	.74	8.46	.000

constructed to assess the dissimilar effects for the structure-by-language interaction under each level of the case variable (figures 18 and 19).

The cause of the three-way interaction becomes obvious when reviewing figures 18 and 19. The general trend for both CAT and CLUS text across ENG, COMP and RTTY is downward, except for the upper CLUS options. Further, there appears to be an unusually high number of errors with the upper, CAT, ENG design and conversely, a comparatively low number of errors with the upper, CLUS, ENG design.

With regard to figure 18 (three-way interaction plot), the following observations can be made. Given the significance of the interaction, other main and two-way effects should not be interpreted independently. However, the results shown in figures 8 and 9 have not been statistically tested, and it is not certain that all observed differences are due to the effects of the independent variables, as opposed to random variation in the data.

The graph indicates that the following distinctions can be made between combinations of the three independent variables:

a. Mixed text (square symbols) generally has fewer errors (except for ENG-upper-CLUS).

b. ENG-upper-CLUS, COMP-mixed, and RTTY-mixed-CAT or RTTY-mixed-CLUS, have the fewest errors.

Examination of the errors associated with option 1, table 3, reveals that 22 of the 24 errors were in reporting the runways incompletely. The difference in the complexity in the answer between design options 1 and 2 may have created this interaction. While an error in the test design may have impacted the results, it does point to the real-world chance that pilots could miss some critical data.

SUBJECTIVE DATA.

Appendix E contains the complete responses received from the participating pilots. Subjective data were received from 59 pilots. The most preferred design options were the COMP language with CAT structure and all upper case (option 3), and the RTTY language with CAT structure and all upper case (option 5). The least-preferred design option was the ENG, regardless of structure or case, that is, options 1, 2, 7, and 8.

DISCUSSION AND RECOMMENDATIONS

DISCUSSION OF RESULTS.

This section reports the results of the study in practical terms. Although it is tempting to address the three original independent variables (case, structure, and language) as if they affected the response time and error data in separate and distinct ways, the presence of statistically significant three-way interactions precludes this. For example, it is not possible to make a general statement about case, with regard to the response time data, because the results change according to type of structure and language. Referring to figure 8, upper-CAT is slowest for ENG, but fastest for RTTY.

Therefore, the following recommendations are based solely on an interpretation of the three-way interactions in the plots for response time and errors (figures 8, 9, and 18). Choices of case, structure, and language for ATIS displays should be based on combinations of those variables that produce the fastest response times, and the lowest error rates.

Review of figures 8, 9, and 18 indicates that the following design options should be considered (in order of preference):

a. COMP-Mixed (CAT or Uncategorized). COMP had the fastest response time for mixed case text. Structure did not have any effect. COMP-mixed also had the lowest error rates, irrespective of structure. This finding almost completely supports the original hypothesis that COMP, in a mixed case format with CAT data, would be best in terms of time and errors.

It is interesting to note that pilots preferred COMP with upper case, and CAT structure, as previously noted. However, for COMP, upper-case text was associated with markedly slower response times, and elevated error rates. It may be that pilot preferences for upper-case text were based more on familiarity, than self-perceived performance.

b. RTTY-Mixed-CAT. In figures 8 and 9, RTTY with CAT structure, showed very similar response times to COMP-mixed case. Case did not have much effect. However, in figure 18, RTTY with

upper case CAT text, was associated with a moderate number of errors. Therefore, the best design selection appears to be RTTY with mixed case, CAT text.

When asked about RTTY, pilots expressed a preference for CAT structure with upper case. This paralleled the objective findings, except for case. Upper case was found to be related to higher errors than mixed case.

c. ENG-CLUS (Upper or Mixed). Pilot responses to ENG were generally 4 or 5 seconds slower than the best results for the other language options. This may have partly been due to the need to page between displays.

The best design choice, if ENG is to be used (according to figure 8), is ENG-CLUS (case had little effect). This is also supported by the data shown in figure 18, that indicates a very low error rate for ENG-CLUS ATIS displays.

Pilots did not express much liking for ENG in any format. Response time performance was slower than the other language options, but errors were comparable.

It should be emphasized that the previously-mentioned recommendations are based on interpretations of graphed data, and are not supported by statistical significance tests. It is recommended that future research be oriented toward testing the three options for display of ATIS information, and that two kinds of general data be collected.

Objective data on pilot response times and error rates should be recorded, and tests designed, to determine the statistical significance of various contrasts. Subjective data on pilot preferences for different display designs, in the form of rating scales and written comments, should also be gathered. Given the concerns expressed by some statisticians about the use of post-hoc tests with within-subjects experimental designs, it would be best to plan the desired comparisons ahead of time.

BIBLIOGRAPHY

Smith, S.L., and Mosier, J. N., Guidelines for Designing User Interface Software, Electronic Systems Division, AFSC, Hanscom AFB, MA, ESD-TR-86-278.1986.

Stramler, Jr., J. H., The Dictionary for Human Factors Ergonomics, CRC Press Inc., 1993

Federal Aviation Administration, Airman's Information Manual, U. S. Government Printing Office, May 27, 1993 Edition.

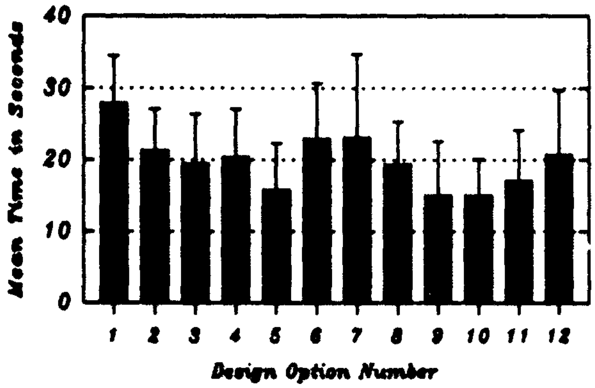

Figure 1. IDU Mean Time by Design Option

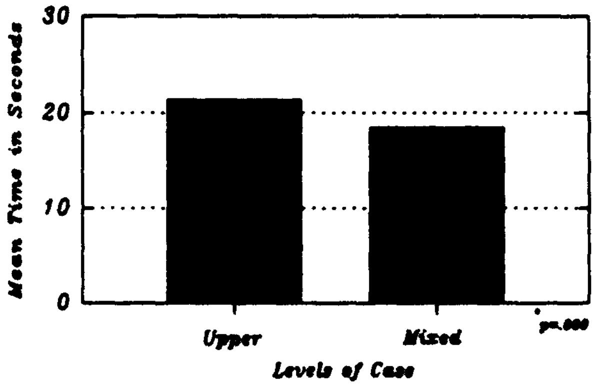

Figure 2. IDU Mean Time by Case

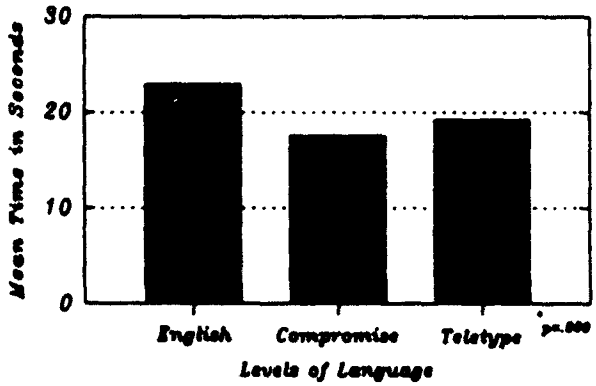

Figure 3. IDU Mean Time by Language

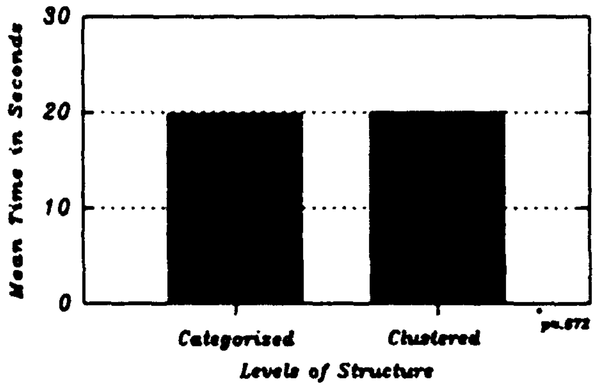

Figure 4. IDU Mean Time by Structure

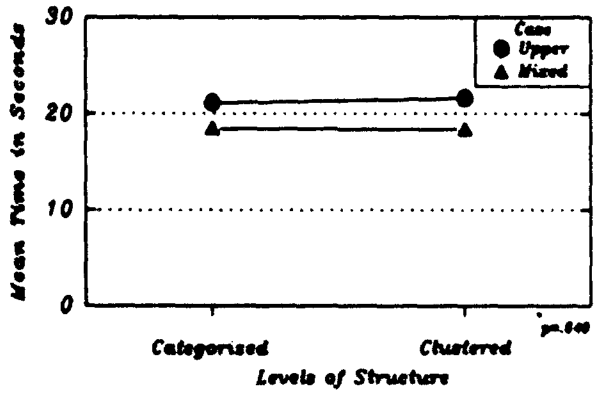

Figure 5. Time: Structure x Case Interaction

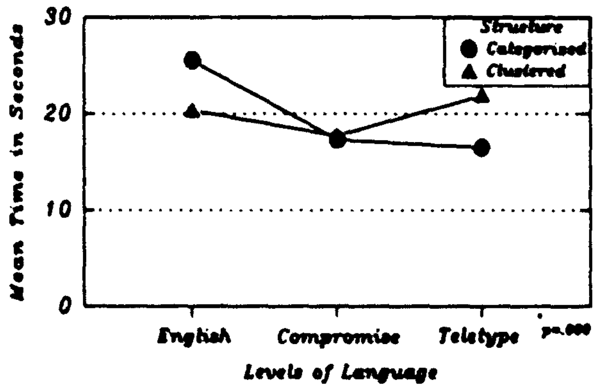

Figure 6. Time: Structure x Language Interaction

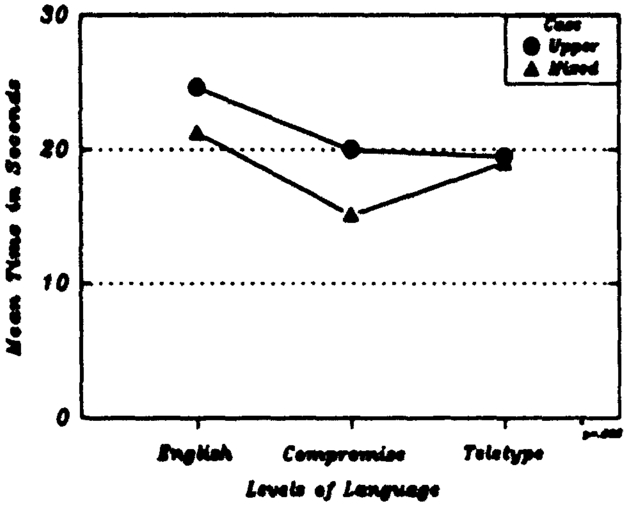

Figure 7. Time: Case x Language Interaction

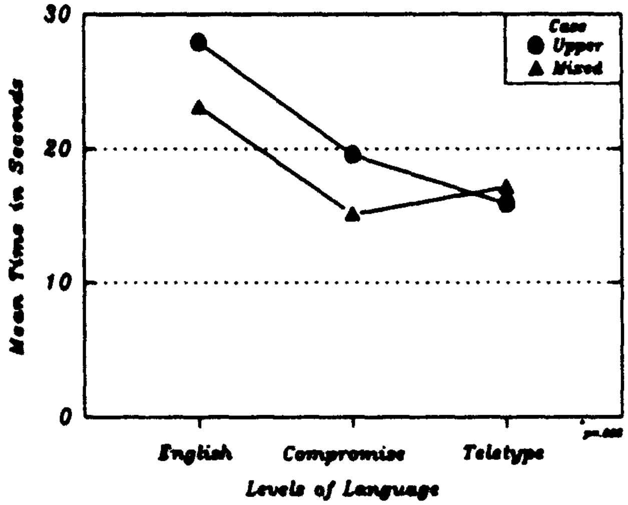

Figure 8. Time: Case x Language (Categorized)

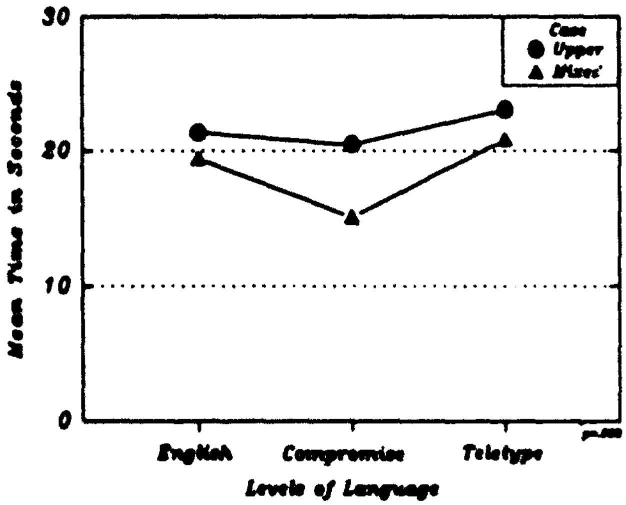

Figure 9. Time: Case x Language (Clustered)

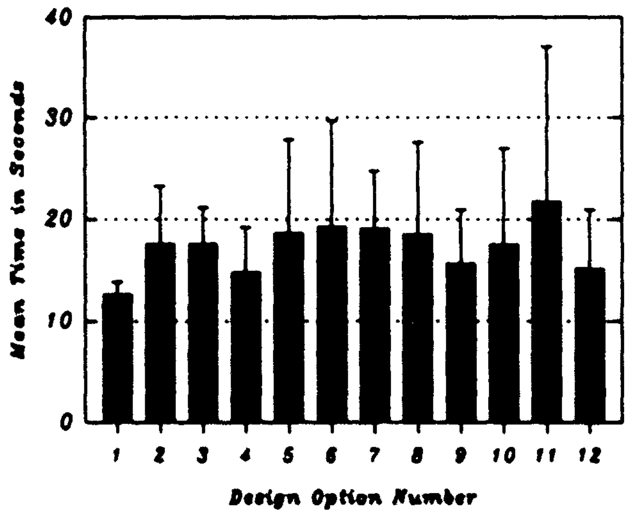

Figure 10. Printer Mean Time by Design Option

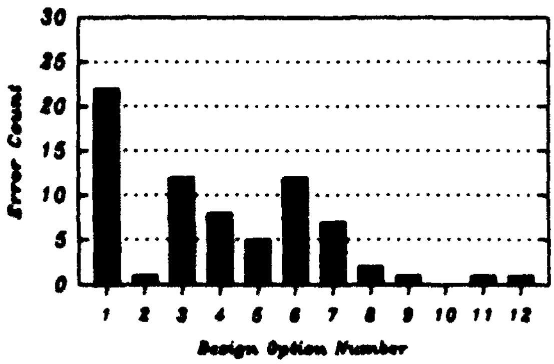

Figure 11. IDU Error Data by Design Option

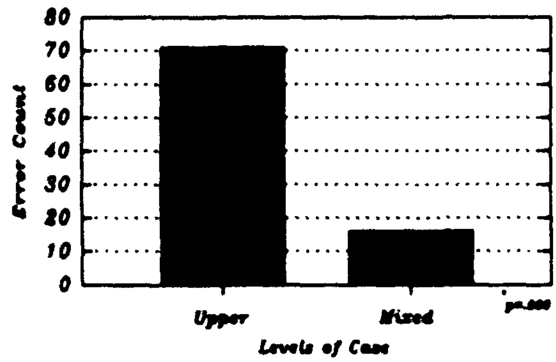

Figure 12. IDU Error Data by Case

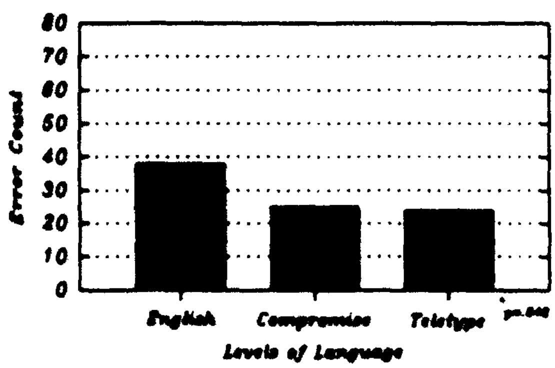

Figure 13. IDU Error Data by Language

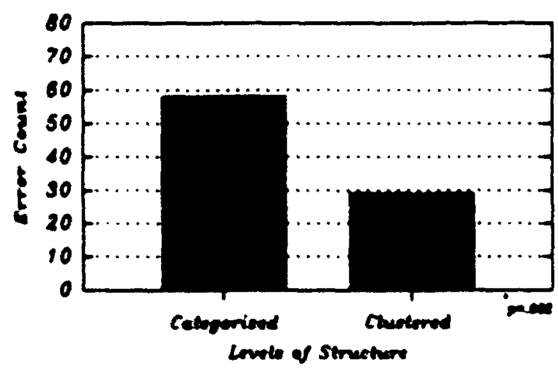

Figure 14. IDU Error Data by Structure

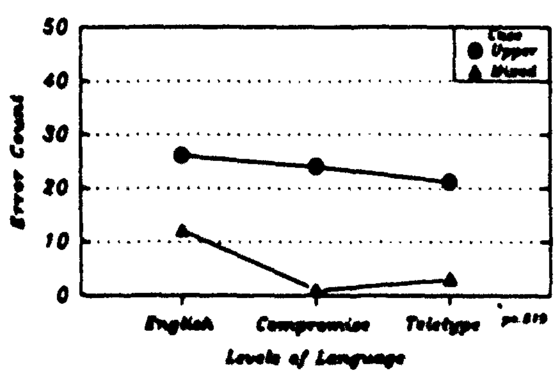

Figure 15. Errors: Case x Language Interaction

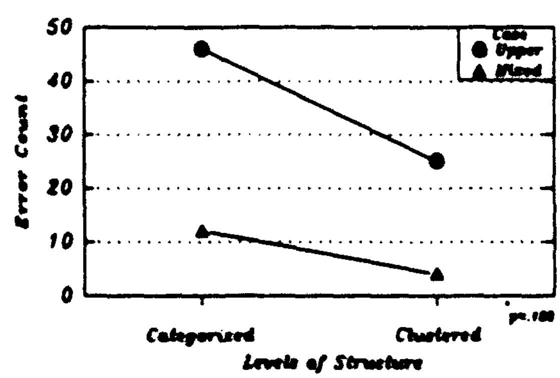

Figure 16. Errors: Structure x Case Interaction

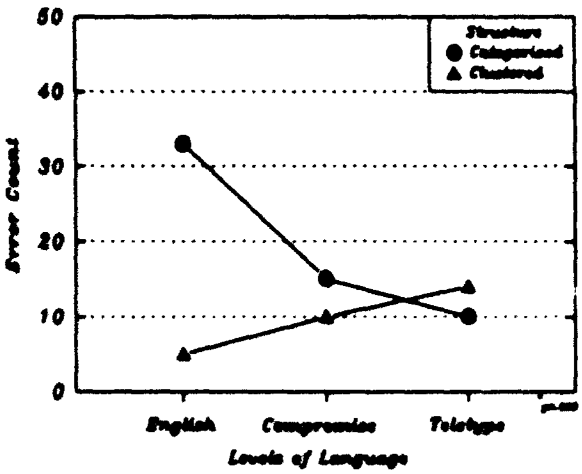

Figure 17. Errors: Structure x Language Interaction

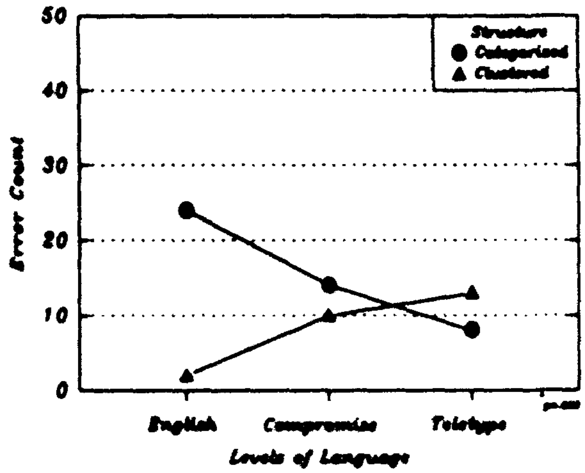

Figure 18. Errors: Structure x Language (Upper)

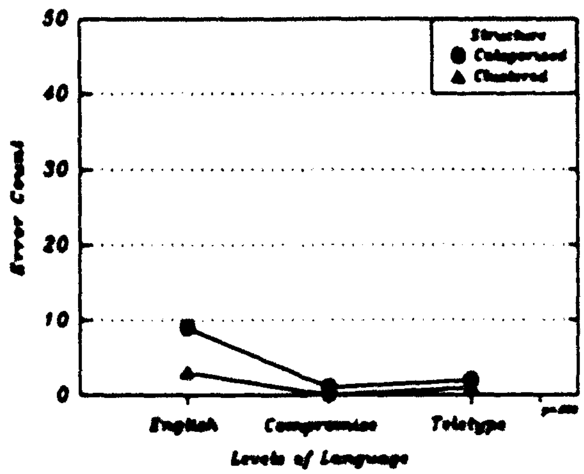

Figure 19. Errors: Structure x Language (Mixed)

APPENDIX A
Experimental Design Options - Teledyne IDU Version

1. <u>ENG - CAT - Upper</u>

PITTSBURGH
INTERNATIONAL ATIS
FOXTROT.

1000 ZULU WEATHER.
MEASURED CEILING TWO
FIVE THOUSAND
OVERCAST. VISIBILITY
FOUR. TEMPERATURE SIX
EIGHT. WIND ZERO NINE
ZERO AT FIFTEEN GUSTS
THIRTY FIVE.
ALTIMETER THREE ZERO
ZERO NINER.

ILS RUNWAY TWO EIGHT
LEFT APPROACH IN USE.
LANDING RUNWAY TWO
EIGHT RIGHT, CENTER
AND LEFT. DEPARTURE
RUNWAY THREE TWO.
ADVISE YOU HAVE
FOXTROT.

2. <u>ENG - CLUS - Upper</u>

PHILADELPHIA
INTERNATIONAL ATIS
TANGO. 1800 ZULU
WEATHER. MEASURED
CEILING FOUR THOUSAND
BROKEN. VISIBILITY
THREE HAZE.
TEMPERATURE EIGHT
TWO. WIND ONE FIVE
ZERO AT FIVE.
ALTIMETER TWO NINER
NINER NINER. ILS
RUNWAY NINE RIGHT
APPROACH IN USE.
LANDING RUNWAY NINE
RIGHT. DEPARTURE
RUNWAY NINE LEFT.
HEAVY BIRD MIGRATION
TO THE SOUTH EAST.

3. <u>COMP - CAT - Upper</u>

BWI ATIS DELTA

1900Z MEAZ CEILING
400 BKN. VISB 2 FOG.
TEMP 64. WIND 180/04
ALT 29.83.

ILS RWY 15R APP IN
USE. LNDG RWY 15L/R
AND 10. DEP RWY 15R.
RWY 22 CLOSD DUE TO
DSBLD ACFT ON RWY.
ADVISE DELTA.

4. <u>COMP - CLUES - Upper</u>

DAY ATIS WHISKEY.
2300Z. 150 SCT. VISB
4 SMOKE. TEMP 74.
WIND 290/05. ALT
2998. ILS RWY 24R APP
IN USE. LNDG RWY 24L
AND 24R. DEP RWY 24R.
CLR DEL 121.75 OTS
CNTCT CLR ON 127.25.
ADVISE WHISKEY.

5. <u>RTTY - CAT - Upper</u>

IAD ATIS OSCAR.

1300Z M30 OVC 3K/68/
1912/992

ILS RWY 1R APP IN
USE. LNDG RWY 1R/L
DEP RWY 30. BRD
ACTVY. ADV YOU HAVE
OSCAR.

6. <u>RTTY - CLUS - Upper</u>

DCA ATIS XRAY 1500Z M10-X. 2TRW. 58/2710/ 994. ILS APP RWY 36 AND VIS APP RWY 33 IN USE. LNDG RWY 36 AND 33. DEP RWY 36. TWY J EDGE LGHTS OTS BTWN RWY 15 AND 18. ADV XRAY.

7. <u>ENG - CAT - Mixed</u>

Pittsburgh International ATIS Echo.

1000 Zulu weather. Measured ceiling two two thousand overcast. Visibility three. Temperature six eight. Wind three one zero at fifteen. Altimeter three zero zero eight.

ILS runway two eight left approach in use. Landing runway two eight right, center and left. Departure runway three two. Advise you have echo.

8. <u>ENG - CLUS - Mixed</u>

Philadelphia International ATIS Bravo. 1800 Zulu weather. Measured ceiling two thousand broken. Visibility four haze. Temperature eight two. Wind one six zero at four. Altimeter two niner niner eight. ILS runway nine right approach in use. Landing runway nine right. Departure runway nine left. Heavy bird migration to the south east. Advise you have Bravo.

9. <u>COMP - CAT - Mixed</u>

BWI ATIS Hotel

1900Z Meas ceiling 800 bkn. Visb 3 fog. Temp 64. Wind 170/05 Alt 29.85.

ILS rwy 15R app in use. Lndg rwy 15L/R and 10. Dep rwy 15R. Rwy 22 closd due to dsbld acft on rwy. Advise Hotel.

10. <u>COMP - CLUS - Mixed</u>

DAT ATIS India. 2300Z. 170 Sct. Visb 3 smoke. Temp 74. Wind 280/04. Alt 2996. ILS rwy 24R app in use. Lndg rwy 24L and 24R. Dep rwy 24R. Clr del 121.75 Ots cntct clr on 127.25. Advise India.

11. <u>RTTY - CAT - Mixed</u>

IAD ATIS Lima

1300Z M40 ovc 4K/68/
1912/990

ILS rwy 1R app in
use. Lndg rwy 1R/L.
Dep rwy 30. Brd
actvy. Adv you have
Lima.

12. <u>RTTY - CLUS - Mixed</u>

DCA ATIS Zulu 1500z
M15 x. 3Trw. 58/2508/
995. ILS app rwy 36
and vis app rwy 33 in
use. Lndg rwy 36 and
33. Dep rwy 36. Twy j
edge lghts ots btwn
rwy 15 and 18. Adv
Zulu.

APPENDIX B

SCENARIO, QUESTION, AND ANSWER FOR EACH OF THE TWELVE OPTIONS

Option 1.

Scenario: Pittsburgh arrival
Question: State the ceiling height, altimeter, and landing runway
Answer: 25,000; 30.09; 28 L/R/C

Option 2.

Scenario: Philadelphia arrival
Question: State the ceiling height, altimeter, and landing runway
Answer: 4000; 29.99; 9R

Option 3.

Scenario: Baltimore-Washington arrival
Question: State the ceiling height, altimeter, and landing runway
Answer: 400; 29.83; 15 L/R & 10

Option 4.

Scenario: Dayton arrival
Question: State the ceiling height, altimeter, and landing runway
Answer: 15,000; 29.98; 24 L/R

Option 5.

Scenario: Dulles arrival
Question: State the ceiling height, altimeter, and landing runway
Answer: 3000; 29.92; 1 L/R

Option 6.

Scenario: Washington-National arrival
Question: State the ceiling height, altimeter, and landing runway
Answer: 1000; 29.94; 36 & 33

Option 7.

Scenario: Pittsburgh departure
Question: State the visibility distance, wind, and departure runway.
Answer: 3; 310/15; 32

Option 8.

Scenario: Philadelphia departure
Question: State the visibility distance, wind, and departure runway.
Answer: 4; 160/4; 9L

Option 9.

Scenario: Baltimore-Washington departure
Question: State the visibility distance, wind, and departure runway.
Answer: 3; 170/5; 15R

Option 10.

Scenario: Dayton departure
Question: State the visibility distance, wind, and departure runway.
Answer: 3; 280/4; 24R

Option 11.

Scenario: Dulles departure
Question: State the visibility distance, wind, and departure runway.
Answer: 4; 190/12; 30

Option 12.

Scenario: Washington-National departure
Question: State the visibility distance, wind, and departure runway.
Answer: 3; 250/8; 36

APPENDIX C
POST-HOC ANALYSES OF IDU TIME DATA

Part I. Analysis of simple effects for the significant two-way interactions:

1. Case by Language (means include both levels of STRUCTURE)

	English (ENG)	Compromise (COMP)	Teletype (RTTY)
Upper	24.62	19.98	19.43
Mixed	21.25	15.07	18.97

Difference between Upper and Mixed case for the ENG Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-ENG vs. Mixed-ENG	255.19	1	255.19	9.55	.003

Difference between Upper and Mixed case for the COMP Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-COMP vs. Mixed-COMP	542.92	1	542.92	38.83	.000

Difference between Upper and Mixed case for the RTTY Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-RTTY vs. Mixed-RTTY	4.76	1	4.76	.26	.613

From a different angle now!

Difference among the 3 language conditions for Upper case only:

Simple Effect	SS	DF	MS	F	Sig of F
Upper (-ENG vs. -RTTY vs. -COMP)	732.23	2	366.12	24.39	.000

Difference among the 3 language conditions for Mixed case only:

Simple Effect	SS	DF	MS	F	Sig of F
Mixed (-ENG vs. -RTTY vs. -COMP)	880.42	2	440.21	16.39	.000

2. Language by Spacing (means include both levels of CASE)

	ENG	COMP	RTTY
Upper	25.53	17.31	16.48
Mixed	20.35	17.74	21.91

Difference between CAT and CLUS for the ENG Language:

Simple Effect	SS	DF	MS	F	Sig of F
CAT-ENG vs. CLUS-ENG	602.43	1	602.43	23.88	.000

Difference between CAT and CLUS for the COMP Language:

Simple Effect	SS	DF	MS	F	Sig of F
CAT-COMP vs. CLUS-COMP	4.07	1	4.07	.20	.660

Difference between CAT and CLUS for the RTTY Language:

Simple Effect	SS	DF	MS	F	Sig of F
CAT-RTTY vs. CLUS-RTTY	663.68	1	663.68	32.17	.000

From a different angle now!

Difference among the 3 language conditions for CAT only:

Simple Effect	SS	DF	MS	F	Sig of F
CAT-ENG vs. CAT-RTTY vs. CAT-COMP	2248.62	2	1124.31	39.88	.000

Difference among the 3 language conditions for CLUS only:

Simple Effect	SS	DF	MS	F	Sig of F
CLUS-ENG vs. CLUS-RTTY vs. CLUS-COMP	400.77	2	200.39	10.55	.000

3. Post-hoc comparisons of means for the three levels of language (ENG, COMP, and RTTY).

ENG	COMP	RTTY
22.94	17.53	19.20

Difference between ENG and RTTY:

Simple Effect	SS	DF	MS	F	Sig of F
ENG vs. RTTY	314.63	1	314.63	24.99	.000

Difference between ENG and COMP:

Simple Effect	SS	DF	MS	F	Sig of F
ENG vs. COMP	659.34	1	659.34	55.02	.000

Difference between RTTY and COMP:

Simple Effect	SS	DF	MS	F	Sig of F
RTTY vs. COMP	63.04	1	63.04	5.94	.019

Part II. Analysis of the CASE by LANGUAGE interaction at each level of STRUCTURE. This was used to isolate the cause of the overall 3-way interaction.

1. Case by Language (CAT only)

	ENG	COMP	RTTY
Upper	27.92	19.53	15.84
Mixed	23.13	15.09	17.12

Difference between Upper and Mixed case for the ENG Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-ENG vs. Mixed-ENG	516.00	1	516.00	6.95	.012

Difference between Upper and Mixed case for the COMP Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-COMP vs. Mixed-COMP	444.00	1	444.00	16.29	.000

Difference between Upper and Mixed case for the RTTY Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-RTTY vs. Mixed-RTTY	36.99	1	36.99	2.43	.126

From a different angle now!

Difference among the 3 language conditions for Upper case only:

Simple Effect	SS	DF	MS	F	Sig of F	
Upper (-ENG vs. -RTTY vs. -COMP)	3447.50	2	1723.75		59.24	.000

Difference among the 3 language conditions for Mixed case only:

Simple Effect	SS	DF	MS	F	Sig of F
Mixed (-ENG vs. -RTTY vs. -COMP)	1572.84	2	786.42	11.97	.000

2. Case by Language (CLUS only)

	ENG	COMP	RTTY
Upper	21.32	20.43	23.02
Mixed	19.38	15.05	20.81

Difference between Upper and Mixed case for the ENG Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-ENG Vs. Mixed-ENG	85.26	1	85.26	3.25	.078

Difference between Upper and Mixed case for the COMP Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-COMP vs. Mixed-COMP	651.79	1	651.79	26.34	.000

Difference between Upper and Mixed case for the RTTY Language:

Simple Effect	SS	DF	MS	F	Sig of F
Upper-RTTY vs. Mixed-RTTY	109.12	1	109.12	1.78	.189

From a different angle now!

Difference among the 3 language conditions for Upper case only:

Simple Effect	SS	DF	MS	F	Sig of F
Upper (-ENG vs. -RTTY vs. -COMP)	155.29	2	77.65	1.97	.145

Difference among the 3 language conditions for Mixed case only:

Simple Effect	SS	DF	MS	F	Sig of F
Mixed (-ENG vs. -RTTY vs. -COMP)	811.11	2	405.55	12.93	.000

3. Post-hoc comparisons of means for the three levels of language (CAT only)

ENG	COMP	RTTY
25.53	17.31	16.48

Difference between ENG and RTTY:

Simple Effect	SS	DF	MS	F	Sig of F
ENG vs. RTTY	**1839.64**	**1**	**1839.64**	**87.22**	**.000**

Difference between ENG and COMP:

Simple Effect	SS	DF	MS	F	Sig of F
ENG vs. COMP	**1517.82**	**1**	**1517.82**	**39.66**	**.000**

Difference between RTTY and COMP:

Simple Effect	SS	DF	MS	F	Sig of F
RTTY vs. COMP	15.46	1	15.46	.61	.438

4. Post-hoc comparisons of means for the three levels of language (CLUS only)

ENG	COMP	RTTY
20.35	17.74	21.91

Difference between ENG and RTTY:

Simple Effect	SS	DF	MS	F	Sig of F
ENG vs. RTTY	54.99	1	54.99	2.42	.127

Difference between ENG and COMP:

Simple Effect	SS	DF	MS	F	Sig of F
ENG vs. COMP	**153.66**	**1**	**153.66**	**9.29**	**.004**

Difference between RTTY and COMP:

Simple Effect	SS	DF	MS	F	Sig of F
RTTY vs. COMP	**392.50**	**1**	**392.50**	**22.15**	**.000**

** BOLDED LINES SIGNIFY EXPERIMENTALLY SIGNIFICANT VARIABLES OR INTERACTIONS.

APPENDIX D
ERROR ANALYSIS

I = Incomplete answer; W = Wrong answer; DNR = Did not report

IDU GROUP

Pilot/option	Error	Correct/reported
Pilot 1.		
Option 2.	W Altimeter	(2999/2982)
Option 4.	W ceiling	(15000/1500)
Option 7.	W Lndg runway	(32/28)
Pilot 2.		
Option 4.	I Lndg runways	(24L/R/24L)
Pilot 4.		
Option 1.	DNR Altimeter	(3009/____)
Pilot 5.		
Option 1.	I runways	(28L/R/C/28R)
Option 8.	DNR winds	(160/4____)
Pilot 7.		
Option 1.	I Lndg runways	(28L/R/C/28)
Pilot 8.		
Option 1.	I Lndg runways	(28L/R/C/28R)
Pilot 9.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 3.	I Lndg runways	(15L/R&10/15L/R)
Pilot 11.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 3.	I Lndg runways	(15L/R&10/15R)
Option 5.	I Lndg runways	(1L/R/1R)
Option 6.	I ceiling	(1000/10000)
Option 8.	W Lndg runways	(9L/9R)
Pilot 12.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 6.	W ceiling	(1000/10000)
	I Lndg runways	(36/33/36)
Option 7.	DNR runway	(32/__)
Pilot 13.		
Option 1.	DNR altimeter	(3009/____)
Option 6.	W ceiling	(1000/1500)

Pilot 15.		
Option 6.	I Lndg runways	(36/33/36)
Pilot 17.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 3.	I Lndg runways	(15L/R&10/15R)
Option 5.	I Lndg runways	(1L/R/1R)
Option 6.	I Lndg runways	(36/33/36)
Pilot 18.		
Option 1.	I Lndg runways	(28L/R/C/28R)
Option 3.	I Lndg runways	(15L/R&10/15L/R)
Pilot 20.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 4.	I Lndg runways	(24L/R/24R)
Pilot 21.		
Option 1.	I Lndg runways	(28L/R/C/28)
Option 3.	I Lndg runways	(15L/R&10/15R)
Option 5.	I Lndg runways	(1L/R/1R)
Pilot 22.		
Option 6.	I Lndg runways	(36/33/36)
Pilot 23.		
Option 3.	I Lndg runways	(15L/R&10/15R)
Pilot 25.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 4.	I Lndg runways	(24L/R/24R)
Option 5.	I Lndg runways	(1L/R/1R)
Option 7.	W Lndg runways	(32/28L)
Pilot 26.		
Option 3.	I Lndg runways	(15L/R&10/15L/R)
Pilot 27.		
Option 6.	W ceiling	(1000/10000)
Pilot 29.		
Option 1.	I Lndg runways	(28L/R/C/28L)
Option 6.	I Lndg runways	(36/33/36)
Option 11.	W Lndg runways	(30/1L/R)
Option 12.	W Visibility	(3 15)
Pilot 30.		
Option 1.	I Lndg runways	(28L/R/C / 28R)
Option 3.	I Lndg runways	(15L/R &10/15L/R)

__Pilot 32__.

Option 1.	I Lndg runways	(28L/R/C / 28L)
Option 3.	I Lndg runways	(15L/R &10/15L/R)

__Pilot 33__.

Option 1.	I Lndg runways	(28L/R/C/28L)
Option 7.	W Lndg runways	(32/1R)
Option 9.	W Lndg runways	(15R/15L)

__Pilot 34__.

Option 7.	DNR Visibility	(3/___)

__Pilot 35__.

Option 4.	I Lndg runways	(24L/R/24L)

__Pilot 36__.

Option 1.	I Lndg runways	(28L/R/C/28L)
Option 3.	I Lndg runways	(15L/R&10/15L/R)
Option 4.	DNR ceiling	(15000/__ _)
	I Lndg runways	(24L/R / 24R)
Option 6.	I Lndg runways	(36/33 / 36)
Option 7.	W Lndg runways	(32 / 28R)

__Pilot 38__.

Option 1.	I Lndg runways	(28L/R/C / 28R/L)
Option 4.	I ceiling	(15000/1500)
Option 5.	I Lndg runways	(1/R / 1R)

__Pilot 39__.

Option 1.	I Lndg runways	(28L/R/C / 28R/L)

__Pilot 42__.

Option 1.	I Lndg runways	(28L/R/C / 28L)
Option 3.	I Lndg runways	(15L/R &10 / 15R)

__Pilot 43__.

Option 6.	I Lndg runways	(36/33 / 36)
Option 7.	W Lndg runways	(32 / 28R/L/C)

__Pilot 44__.

Option 1.	I Lndg runways	(28L/R/C / 28R)
Option 3.	I Lndg runways	(15L/R &10/15L/R)
Option 6.	I Lndg runways	(36/33 / 36)

PRINTER GROUP

Pilot 46.

Option 5.	I Lndg runways	(1/R / 1R)
Option 7.	W Wind	(310 / 300)

Pilot 47.

Option 1.	I Lndg runways	(28L/R/C / 28L)
Option 3.	I Lndg runways	(15L/R &10/ 15R)
Option 4.	I Lndg runways	(24L/R / 24R)
Option 5.	I Lndg runways	(1/R / 1R)

Pilot 48.

Option 1.	I Lndg runways	(28L/R/C / 28L)
Option 2.	W Ceiling	(4000 / 2000)
Option 3.	I Lndg runways	(15L/R &10/ 15R)
Option 4.	I Lndg runways	(24L/R / 24R)
Option 5.	I Lndg runways	(1L/R / 1R)
Option 6.	I Lndg runways	(36/33 / 36)
Option 7.	W Lndg runways	(32/28L)
Option 8.	W Lndg runways	(9L / 9R)
Option 11.	W runway	(30 / 1R)

The errors made by format and information category are listed below, along with a listing of the pilot numbers. The IDU pilots are numbered 1-45 and the printer pilots are numbered 46-49.

Option No.	Information Category	Pilot
1	Altimeter	4,13
	Runway	5, 7-9, 11, 12, 17, 18, 20, 21, 25, 29, 30, 32, 33, 36, 38, 39, 42, 44, 47, 48
2	Altimeter	1
	Ceiling	47
3	Runway	9, 11, 17, 18, 21, 23, 26, 30, 32, 36, 42, 44, 47, 48
4	Ceiling	1, 36, 38
	Runway	2, 20, 25, 35, 36, 47, 48
5	Runway	11, 17, 21, 25, 38, 46, 47, 48
6	Ceiling	11-13, 27

6	Ceiling	11-13, 27
	Runway	12, 15, 17, 22, 29, 36, 43, 44, 48
7	Visibility	34
	Wind	45
	Runway	1, 12, 25, 33, 36, 43, 48
8	Wind	5
	Runway	11, 48
9	Runway	33
11	Runway	29, 48
12	Visibility	29

Error type

Incorrect responses: 19
Incomplete responses: 62
Did not respond: 6

Errors by Option and display type

Option:	1	2	3	4	5	6	7	8	9	10	11	12
IDU No. Errors:	22	1	12	8	5	12	7	2	1	0	1	1
Printer No. Errors	2	1	2	2	3	1	2	1	0	0	1	0

Error totals and percentages

IDU Errors:	72	(45 Pilots)	1620 trials	4.4% error rate
Printer errors:	15	(4 pilots)	144 trials	10.4% error rate
Total errors:	87	(49 pilots)	1764 trials	4.9% error rate

Errors by variable level

LANGUAGE		CASE	STRUCTURE
ENG	38	Upper 71	CAT 58
COMP	25	Mixed 16	CLUS 29
RTTY	24		

APPENDIX E

PILOT QUESTIONNAIRE DATA

This appendix contains the post-test questionnaire data from 59 pilots. The question is presented first, followed by results (selections, comments, count by group, etc.). In the comments section, the notation #3, for example, indicates the third pilot made the comment, which follows. This does not identify the pilot in any way, but represents a way for the experimenters to track the comments internally. All data provided were available. Some data were not provided by the pilots per their choice.

The first question also provides an indication of the current aircraft of the pilot along with his/her responses. Chart 1 lists, for each pilot, those tested design options (by number) that would be acceptable on the flight deck. Conversely, Chart 2 lists those that are unacceptable. The conditions associated with the numbers listed is shown below in a legend (language, structure, & case). At the bottom of each chart is a summation by design option; interpretation is difficult since 15 pilots did not provide a complete response, and three pilots did not provide any response whatsoever.

1.	ENG - CAT - Upper	2.	ENG - CLUS - Upper
3.	COMP - CAT - Upper	4.	COMP - CLUS - Upper
5.	RTTY - CAT - Upper	6.	RTTY - CLUS - Upper
7.	ENG - CAT - Mixed	8.	ENG - CLUS - Mixed
9.	COMP - CAT - Mixed	10.	COMP - CLUS - Mixed
11.	RTTY - CAT - Mixed	12.	RTTY - CLUS - Mixed

<u>Question 1</u>. Establish two groups with the 12 options--one group contains acceptable flight deck options and the other group contains unacceptable flight deck options. Use the number designator supplied with each option. In general terms, tell us why you grouped them as you did. Any number of options in each group--you decide.

CHART 1. ACCEPTABLE FLIGHT DECK OPTIONS

Pilot	A/C Type	1	2	3	4	5	6	7	8	9	10	11	12
1				X									
2	DC9					X						X	
3				X	X	X	X			X			
4				X	X	X	X			X			
5	737	X	X	X		X		X	X				
6	DC9												
7				X	X	X	X			X	X	X	X
8	737	X		X	X	X		X				X	
9	F100	X	X	X									
10	757				X								
11				X	X	X	X			X	X	X	X
12	727			X	X	X	X			X			
13	DC9			X	X	X	X			X	X	X	X
14	MD-80			X	X	X	X			X	X	X	X
15	757			X	X	X	X			X			
16	737			X	X								
17				X		X				X		X	
18				X		X							
19				X		X				X		X	
20	F100			X									
21	737			X						X			
22	757			X		X	X			X	X	X	X
23	L1011			X	X	X	X			X	X	X	X

CHART 1. ACCEPTABLE FLIGHT DECK OPTIONS (cont.)

Pilot	A/C Type	1	2	3	4	5	6	7	8	9	10	11	12
24	757				X	X	X					X	
25	727			X		X						X	
26	MD-88			X	X	X	X						
27	727	X	X	X	X	X	X	X		X	X	X	X
28	MD-88			X	X	X	X					X	X
29	727	X	X	X	X		X	X		X		X	
30	MD-88	X	X	X	X			X	X	X	X		
31	L1011			X	X	X	X			X	X	X	X
32	757			X	X	X	X			X	X	X	X
33						X	X						
34	727					X							
35	L1011					X							
36	727												
37													
38	MD-88			X		X				X		X	
39	L1011			X		X				X		X	
40	757					X						X	
41	L1011	X		X		X	X	X		X		X	
42	L1011									X	X	X	X
43	MD-80			X	X		X			X	X		
44	757			X		X				X			
45	767					X				X		X	
46	F100	X				X							

CHART 1. ACCEPTABLE FLIGHT DECK OPTIONS (cont.)

Pilot	A/C Type	1	2	3	4	5	6	7	8	9	10	11	12
47	767			X	X	X	X						
48	767	X	X	X	X			X	X	X	X		
49				X	X	X	X						
50	747	X	X	X	X	X	X	X	X	X	X	X	X
51												X	
52	737			X	X	X	X						
53				X	X	X	X						
54						X							
55				X	X	X	X	X	X	X	X	X	X
56					X		X						
57								X	X	X	X	X	X
58				X		X							
59				X		X							
Sum		10	7	42	29	42	27	10	6	29	16	27	14

Reasons:

1. Option 3 - Good combination of standard format and descriptive verbiage.

   Break between Wx and Airport information.

2. Option 5, 11 - Short to the point, and in the format we are used to seeing.

3. Option 3, 4, 5, 6, 9 - Capital letters and concise.

4. Option 3, 4, 5, 6, 9 - I like the upper case, abbreviated formats.

5. Option 1, 2, 3, 5, 7, 8 - I prefer as much plain English as possible others not as good, but acceptable.

7. Option 3, 4, 6, 8, 9, 10, 11, 12 - Familiar format.

8. Option 1, 3, 4, 5, 7, 11 - Ability to most easily and accurately retrieve the needed information.

9. Option 1, 2, 3 - Easy to read and understand.

10. Option 4 - Easy to read and interpret information.

11. Option 3, 4, 5, 6, 9, 10, 11, 12 - Information was short and to the point, information was easy to find.

14. Option 3, 4, 5, 6, 9, 10, 11, 12 - Abbreviated style easier to quickly read and decipher.

15. Option 3, 4, 5, 6, 9 - Clearer to read.

16. Option 3, 4 - Human factors, user friendly.

17. Option 5, 11 - Information is easily read and presented in a format that I am using. Option 3, 9 - Are also good in that the restriction to Vis is given in plain English, however telling me ceiling and Vis seems to be redundant because I know the order in which the information should be presented.

18. Option 3, 5 - Five is best, it is short and easily read. Upper case letters tend to read better with numbers, abbreviations.

20. Option 3 - Grouping readability, acceptable abbreviation.

21. Option 3, 9 - Ease of readability.

23. Option 3, 4, 5, 6, 9, 10, 11, 12 - Short concise, common abbreviating.

24. Option 4, 5, 6, 11 - Known Wx symbology, simple to read.

25. Option 3, 5, 11 - Clear, concise, familiar format. Easy to pick out pertinent information.

26. Option 3, 4, 5, 6 - Five is best. Ideally, it should be close to what we would write on our kneeboards when listening to current ATIS. Short but easy to understand.

28. Option 3, 4, 5, 6, 11, 12 - More concise WX symbology.

29. Option 1, 2, 3, 4, 6, 7, 9, 11 - Easy to read, less chance for miscommunication, better categorized for locating desired data.

31. Option 3, 4, 5, 6, 9, 10, 11, 12 - Numbers are easier to read when written as numbers.

32. Option 3, 4, 5, 6, 9, 10, 11, 12 - Compact, easy to read.

33. Option 5, 6 - Five is better, WX standard format, normal information upper case.

34. Option 5 - Easy to read in groups, standard WX abbreviations.

35. Option 5 - Upper case, separation of data.

38. Option 3, 5, 9, 11 - Scan readability is good, could be better.

39. Option 3, 5, 9, 11 - Like the categorized spacing and conventional numbers format.

41. Option 1, 3, 5, 6, 7, 9, 11 - Info that is needed is easily found.

42. Option 9, 10, 11, 12 - Easier to read the lower case non-English.

43. Option 3, 4, 6, 9, 10 - Generally these choices provide space between paragraphs and they do not use teletype abbreviations.

44. Option 3, 5, 9 - Familiar reporting format, information is grouped conveniently.

45. Option 5, 9, 11 - Easy to read format separating information into different paragraphs. No. 5 is easiest to read because it uses upper case letters and standard codes. I can easily pick out individual pieces of information without searching through the whole report.

48. Option 1, 2, 3, 4, 7, 8, 9, 10 - No problem with interpretation, new guys can interpret differences.

49. Option 3, 4, 5, 6 - For new guys the 3, 4 options may be especially helpful.

50. Option (ALL) - New guys can deal with English version better, especially internationally.

55. Option 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 - All OK some better than others.

59. Option 3, 5 - Compromise good for NOTAMS.

Chart 2. UNACCEPTABLE FLIGHT DECK OPERATIONS

Pilot	A/C Type	1	2	3	4	5	6	7	8	9	10	11	12
1									X				
2	DC-9		X						X				
3		X	X					X	X		X	X	X
4		X	X					X	X				
5	737												
6	DC-9												
7		X	X					X	X				
8	737		X				X		X	X	X		X
9	F100												
10	757												
11		X	X					X	X				
12	727	X	X					X	X		X	X	X
13	DC-9		X					X	X				
14	MD-88	X	X					X	X				
15	757	X	X					X	X		X	X	X
16	737		X						X				X
17		X	X		X		X	X	X		X		X
18		X	X		X		X	X	X	X	X	X	X
19		X	X		X		X	X	X		X		X
20	F100		X										
21	737		X				X		X		X		X
22	757	X	X		X			X	X				
23	L1011	X	X					X	X				

Chart 2. UNACCEPTABLE FLIGHT DECK OPERATIONS (cont.)

Pilot	Type	1	2	3	4	5	6	7	8	9	10	11	12
24	757	X	X	X				X	X	X	X		X
25	727	X	X						X				X
26	MD-88	X	X					X	X	X	X	X	X
27	727								X				
28	MD-88	X	X					X	X	X	X		
29	727					X			X		X		X
30	MD-88					X	X					X	X
31	L1011	X	X					X	X				
32	757	X	X					X	X				
33		X	X										
34	727		X						X				
35	L1011	X	X	X	X		X	X	X	X	X	X	X
36	727												
37													
38	MD-88	X	X		X		X	X	X		X		X
39	L1011	X	X		X		X	X	X		X		X
40	757	X	X					X	X				
41	L1011		X		X				X		X		X
42	L1011	X	X					X	X				
43	MD-80	X	X			X		X	X			X	X
44	767	X	X		X		X	X	X		X	X	X
45	767	X	X	X	X		X	X	X		X		X
46	F100			X				X	X	X	X	X	X
47	767	X	X					X	X	X	X	X	X

Chart 2. UNACCEPTABLE FLIGHT DECK OPERATIONS (cont.)

Pilot	Type	1	2	3	4	5	6	7	8	9	10	11	12
48	767					X	X					X	X
49		X	X					X	X	X	X	X	X
50	74												
51		X	X	X	X	X	X	X	X	X	X		X
52	73	X	X					X	X	X	X	X	X
53		X	X					X	X	X	X	X	X
54													
55		X	X										
56		X	X	X		X		X	X	X	X	X	X
57		X	X	X	X	X	X						
58		X	X		X		X	X	X	X	X	X	X
59		X	X		X		X	X	X	X	X	X	X
Sum		38	45	7	14	7	16	35	45	15	27	18	31

Reasons:

1. Option 8 - Too much verbiage in mixed case, difficult to read.

2. Option 2, 8 - Too long and wordy, would probably have to copy the information on a piece of paper (like we do with voice ATIS) to make it useful.

3. Option 1, 2, 7, 8, 10, 11, 12 - Lower case or too long.

4. Option 1, 2, 7, 8 - Too much verbiage, takes too long to ferret out the information you need.

7. Option 1, 2, 7, 8 - Too much reading, not format we use.

8. Option 2, 6, 8, 9, 10, 12 - Cluttered display, some information is difficult to retrieve unless entire script is read.

11. Option 1, 2, 7, 8 - It required too much time to read.

12. Option 1, 2, 7, 8, 10, 11, 12 - I don't like numbers written out as in option 1, 2, 7, 8 and I don't like mixed "case" letters as in option 10, 11, 12.

13. Option 1, 2, 7, 8 - Too cluttered.

14. Option 1, 2, 7, 8 - Full Text too hard to read, too confusing.

15. Option 1, 2, 7, 8, 10, 11 - Not clear.

16. Option 2, 8, 12 - Too long and user unfriendly.

17. Options 1, 2, 7, 8 are difficult to read. We are used to seeing numbers to identify Vis, alt and Rwys. When they are presented as words they become difficult to identify. Options 4, 6, 10, 12 the information is run-on and difficult to pick out necessary information.

18. Options 1, 2, 7, 8 - Too long with all the words spelled out. Options 6, 9, 10, 11 - Lower case and numbers don't mix well. Options 4, 10, 11 - One large clump is harder to dig through.

19. Option 1, 2, 4, 6, 7, 8, 10, 12 - In general too long; keep it to one page if possible.

20. Option 2 - Much too long.

21. Option 2, 6, 8, 10, 12 - Clutter, Confusion.

23. Option 1, 2, 7, 8 - Too long, Too wordy.

24. Option 1, 2, 3, 7, 8, 9, 10, 12 - Cluttered, unfamiliar abbreviations.

25. Option 1, 2, 8, 12 - Need breaks between portions of information. Length of message requires too much time to read and absorb.

26. Option 1, 2, 7, 8, 9, 10, 11, 12 - Too verbose takes too long to read when we need to be looking for traffic. Mixed letter case is harder to read on this display. Our current computers use all upper case so it would mix better.

27. Option 8 - Too much verbiage.

28. Option 1, 2, 7, 8, 9, 10 - Less concise.

29. Option 5, 8, 10, 12 - Too cluttered too long to find info. Some acronyms easily confused, numbers transposed.

30. Option 5, 6, 11, 12 - Too easy to make a mistake when looking quickly.

32. Option 1, 2, 7, 8 - Takes too long to find useful information.

33. Option 1, 2 - Too much reading, much harder to pick out needed information.

34. Option 2, 8 - Clustered should read Cluttered. I liked easy to read versions and this takes too long to read through. If I can't get information at a glance, I may miss it.

35. Option 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12 - Difficult to read quickly; no spacing between different pieces of information; mixed case; non-standard abbreviations.

38. Option 1, 2, 4, 6, 7, 8, 10, 12 - Scan readability is UNSAT, horrible.

39. Option 1, 2, 4, 6, 7, 8, 10, 12 - Too many words, or too much text all run together.

41. Option 2, 4, 8, 10, 12 - Must first read entire case to find the information needed.

42. Option 1, 2, 7, 8 - Too lengthy, difficult to read.

43. Option 1, 2, 5, 7, 8, 11, 12 - These choices tend to use teletype abbreviations which cause confusion. Some of these choices use full English which is tough to quickly retrieve info from.

44. Option 1, 2, 4, 6, 7, 8, 10, 11, 12 - Too much reading involved.

45. Option 1, 2, 3, 4, 6, 7, 8, 10, 12 - Difficult to read, too busy. All information receives equal weight of importance. Difficult to find specific information.

46. Option 3, 7, 8, 9, 10, 11, 12 - No. 3 is unacceptable because compromise language often leaves one wondering what is being meant (Ex. should zeros be added to ceiling?).

48. Option 5, 6, 11, 12 - Can be sent incorrectly, as well as interpreted incorrectly.

Question 2. Which lettering style is best, all upper case or mixed case?

Upper Case	Mixed Case
42	12

Comments:

9. Not sure why I liked the upper case, but it could be that it is what I am use to looking at.

17. All upper case is what we are use to seeing in the current system. When you switch to mixed case it seems to take longer to read, because you are expecting all upper case.

33. Upper case for normal information, and the lower case English for detailed NOTAMS.

Question 3. Which "language" is best, full English, teletype, or the compromise?

English	Teletype	Compromise
4	28	30

Comments:

18. Teletype, ex. OVC SCT for WX in upper case, abbreviate (like option #5).

29. Compromise as long as abbreviations aren't confusing with other aviation acronyms.

32. Would be nice to have WX information in teletype with compromise used for normal information.

45. Combine compromise and teletype.

49. Teletype for Wx, compromise for NOTAMS.

50. English for international, compromise for NOTAMS.

53. English or compromise for NOTAMS and remarks.

56. Teletype for Wx, compromise for NOTAMS.

Question 4. Which structure is best, the single cluster or the categorized?

Clustered	Categorized
5	54

Question 5. Should ATIS be delivered over ACARS, voice (as now) or both?

ACARS	Voice	Both
8	0	48

Comments:

2. ACARS, probably should retain the voice option for the near future.

4. Both to allow a backup to allow for ACARS failure and dispatch without ACARS.

8. Both, ACARS is a definite plus.

9. Both, ACARS would be my first option.

11. Over ACARS it doesn't take as long to get the information you want, and if you miss something you can find it a lot faster.

12. ACARS is easier to obtain the information from a display, many times you miss hearing what you need and have to wait for the message to repeat.

13. Both with voice backup.

20. Over ACARS, there is already far too much audio communications. Plus, crews can refer to condition for items they might miss.

28. Need both to have backup in case ACARS is inoperative.

33. Voice, ACARS for arrival is nice feature.

Question 6. How valuable would a "printout" of the ATIS be?

1 = High, 5 = Low

Average	Standard Deviation
2.6	1.77

Comments:

4. Too expensive for the value.

8. No value provided the ACARS has message recall capability.

17. Since the ACARS stores all messages, it is just like having a printout.

18. It would be nice to have the option. A printout would be nice for cases where there are a lot of NOTAMS, e.g., during construction, a lot of taxi ways are closed. It would be nice to be able to compare a written (printed) copy to the airport diagram.

26. As long as information is kept in memory and can be recalled.

28. Assuming readout could be sustained on ACARS display.

33. 95% of time low, 5% of the time it would be nice.

54. Screen only would be detrimental.

Question 7. Should the avionics be "smart" enough to recognize critical data within an ATIS message and then highlight that data in some way? For example, if the winds are beyond some critical speed and/or direction for the aircraft type, should the wind data flash or otherwise be distinguished from the other "normal" data.

Yes	No
39	19

Comments:

4. Yes, I would appreciate any help I can get, as long as this is not restrictive. Highlight the information, let me decide what to do about it.

7. What is critical in one's eyes is not for another.

8. Could be a nice feature but should not be considered necessary.

10. Contaminated Runways, X-wind restriction if all A/C limitations are in ACARS it would be very helpful.

11. It would be nice but really not necessary.

12. It would be nice but could get along without it.

17. This would be helpful to remind you that there may be something to be more aware of.

18. No - too many warnings (whistles and bells) in cockpit now.

20. Ideal situation, but is it cost effective; who decides what should be highlighted?

24. Good idea, but is it cost effective? (bells and whistles)

28. Good idea.

30. Not necessary.

32. Instead of A/C type pick boundary limit, i.e. 15/20 KTS X-WIND GUSTS > 10 KTS etc., make it universal vice A/C specific.

33. Would be a nice feature but all this information could change for your aircraft. For example, MEL items would change allowable wind conditions. Is it worth the cost to put all the cases in memory.

39. It would be nice, but would have to be programmed by A/C and may depend on approach type being flown. Not Very Realistic.

45. Using bold print for critical information.

48. Color really helps.

49. Want all the data. Maybe separate routine - nonroutine NOTAMS.

50. Separate into a paragraph "critical" information.

52. Chime with urgent (SP) level, no chime on normal (SA).

Question 8. Would a graphical representation of certain parts of the ATIS be "better" than the words? Explain and/or show some examples.

Yes	No
8	43

Comments:

4. The most unmistakable way to present the WX would be a standardized format such as: PIT INFO ALPHA

   CEIL:
   VIS: include observations
   TEMP/DP:
   ALT:

6. Yes, winds and altimeter.

7. SCT, BKN, etc. Old style WX.

8. Neutral feelings on this - would have to see proposals.

12. Yes, don't like plain English.

15. M30 OVC 3F 68 280/12 998 = Best Format.

16. Airport information should be short, not a "laundry list".

24. OVC = overcast BKN = BROKEN SCT = SCATTERED

38. No, at least I don't think so!

39. No, can't think of any.

42. No, too difficult.

49. Yes, radar summary.

58. Yes, Rwy layout and any Sig. Wx, taxiway/runway structure.

<u>Question 9</u>. Would a symbolic representation of the weather information within the ATIS be "better" than the words? Explain and/or show some examples.

Yes	No
13	43

Comments:

3. OVERCAST SCATTERED

4. Use the compromise like option #3, except show ceiling and cloud height in standard format- eg. 40 is 4000' overcast.

10. No, direct reading of information versus decoding.

16. Easy to read "user friendly" text is best.

17. It would seem that symbology would tend to get lost in text.

18. No, use OVC instead of etc.

20. You need pertinent information that does not require interpretation, too easy to make mistakes with symbology.

21. Confusion, compromise language preferred.

27. People forget some symbols, clear text is unambiguous.

28. Yes, more concise, pilots already familiar with format.

32. No, I can't read Air Force WX.

33. No, one standard.

39. No, I don't mind the symbols, But they may not be familiar to everyone; think the text should be consistent with the current printed WX reports we get.

<u>Question</u>: How would you suspect the delivery of ATIS over ACARS would affect:

10) The <u>ABILITY TO MANAGE</u> your workload?

11) Flight safety?

Mark one:		Mark one:	
6	Decrease significantly	1	Decrease significantly
5	Decrease slightly	0	Decrease slightly
1	No change	5	No change
23	Increase slightly	33	Increase slightly
23	Increase significantly	18	Increase significantly

Comments:

<u>Question #10</u>.

4. I like the idea.

12. It would make it better.

28. By decreasing audio workload.

Question #11.

16. Much less distraction in critical phase of flight.

18. Many times, the pilots are interrupted while listening to the ATIS, and end up listening to the tape 3 or 4 times. This time is diverted from flying & monitoring the aircraft and ATC.

Question 12. As currently implemented, radio ATIS is a continuous broadcast service; on ACARS, ATIS will be a request-reply service. Answer the following questions and provide explanations where possible.

12a) Should ATIS updates be automatically data linked to the flight deck after the initial request?

Yes	No
49	9

Comments:

4. Yes, similar to flashing messages we now have.

10. Yes, case in point frontal passage TRW activity, RWY condition.

11. Yes, that way you always have the up to date information.

[illegible]. No, most pilots know when a new ATIS is scheduled to come out and if the weather is changing rapidly tower gives the information as the aircraft comes on frequency.

20. Yes, if information changes crew would be alerted immediately, rather than have to be told by ATC that information has been changed or updated.

21. Yes, if cost effective.

23. No, time is on ATIS an will advise if you don't have current.

24. Yes, for maybe 30 minutes automatically, then by request.

26. No, we'll ask again if needed. If it's severe WX, we would expect to hear that from approach as a flight precaution.

30. Be nice, but not necessary.

32. Yes, tied into wheels up or postflight message.

43. Yes, the computer will know which ATIS broadcast you have received, therefore it can/should update as appropriate.

45. Yes, saves time/workload. Communication between pilot and controller would be reduced.

46. Yes, within a reasonable time and not after "off/on" event has occurred.

52. Not after switch to APP.

55. Yes, for the destination only.

57. Yes, update only change from previous.

12b) Should each update be annunciated upon delivery?

<u>Yes</u>	<u>No</u>
47	*11

Comments:

6. Only if significant.

10. No, check it yourself.

11. Yes, it would draw your attention to it so you don't miss it.

20. Yes, some sort of alert to ensure crews note the updated info.

21. Yes, screen only/silent.

25. Yes, timing is important. There needs to be a point where any further interruptions in cockpit are inhibited. Perhaps below 10,000'.

26. No more flashing lights on approach. Bad for safety.

32. Yes, have non-auditory delivery, no chimes.

33. Yes, would prompt you for ATIS change.

34. Yes, not too overbearing.

45. Yes, as long as annunciation does not cause distraction in a critical phase of flight.

49. Yes, no sounds, do visuals.

Question 13. The ATIS is basically divided up into weather conditions (sequence report), facility information (instrument approach and runway in use) and general remarks (NOTAMS).

13a) Is this order representative of the importance of the information?

Yes	No
50	8

Comments:

4. No, WX/AF Data/NOTAMS (The order is not really significant, we need it all).

7. No, sequence, APP, then NOTAMS.

8. No, NOTAMS are generally last even in the current voice format - I support that concept.

14. No, WX - first, Landing Data - second, NOTAMS - third.

16. No, NOTAMS last, limit NOTAMS to only very important.

18. No, WX, APP, NOTAMS.

19. Yes, keep with same voice sequence.

26. Yes, we use it just that way.

28. Yes, this order is okay - pilots are used to it - don't change.

32. Yes, a good place to mix using teletype and compromise language, i.e. WX is teletype and rest in compromised.

44. This order is important for ease of comprehension.

13b) Are there any single pieces of information (e.g., wind speed, temperature) that are always more important than the rest?

Yes	No
20	38

Comments:

2. No, retain the standard report sequence order.

4. No, not unless it represents an out of limits condition.

6. Yes, ceiling, vis, wind.

11. Yes, ceiling, temp, land rwy, vis, wind.

14. Yes, wind.

16. Yes, multiple ceiling layers above 1000'.

18. No, list them as they have always appeared in written form.

20. No, complete information package is required for safety's sake.

21. Yes, special information.

22. Yes, ceiling and vis.

23. Yes, depends on WX, how ceiling vis is more important than wind, or wind more important than clr.

25. Yes, certainly high wind speeds, wind shear info., low ceiling vis tend to be more important.

27. Yes, vis and winds.

32. Yes, approach in use. Set it up 100mi out.

33. No, Depends on WX conditions, low ceilings or high winds, etc.

38. Yes, ceiling, vis, winds, and altimeter.

39. Yes, depends on departure or arrival phase.

50. Yes, runway.

13c) If yes, please list the information and order important to you.

Comments:

8. WX - App/Rwy - NOTAMS (present format).

9. wind - altimeter.

10. ceiling/vis - wind - rwy conditions i.e. NOTAMS.

11. ceiling - vis - temp - wind - land rwy.

14. wind - vis - ceiling.

22. ceiling - vis - wind - approach.

25. wind shear - T.S. activity - low ceilings/vis.

27. vis has to be good enough to land - winds have to be in limits.

29. runway in use - ceiling - altimeter - winds -temp - NOTAMS.

32. app - wx - ceiling - wind.

36. landing or departing rwy may be placed first.

39. Departure (temp - altimeter - winds - runway), Arrival (ceiling altimeter - winds - runway).

40. ceiling vis - winds - extreme temps.

41. winds - ceiling - vis.

13d) If yes, would you like to see the information reorganized to reflect your order of importance?

Yes	No
7	12

Comments:

14. No, keep format NWS uses - consistency.

25. No, I would prefer to keep same format just delineate abnormal (low, high, etc.) information by flashing, different type size.

38. No, but highlight!

39. No, keep it in standard order, so we know where to look.

13e) What additional information would you like to see within the ATIS message?

Comments:

4. Keep it simple and short, let me know if it changes.

6. Delays.

12. Dewpoint.

23. Shortened message.

27. Flow delays.

29. Any applicable company NOTAMS or helpful info at specific field, i.e. - local variations, requirements, gate #'s.

32. Safety of flight PIREPS.

33. Surface conditions in winter operations.

34. Don't overload information into ATIS message.

35. Departure and arrival delay status and reason why, very important for arriving flights and fuel/diversion considerations.

40. PIREPS.

52. Sigmets on departure, Wx map.

54. More immediate information on terminal area.

13f) What information would you like to see deleted from the ATIS message?

Comments:

2. Tower frequencies that are already listed on airport diagram.

4. Numerous taxiway closures/ramp construction information is often overwhelming

   ... If possible keep message to one screen.

16. Too many "K-mart" airport information.

23. Unnecessary NOTAMS - i.e. ones that are already in written notice.

26. Last line of "Advise you have ______ wastes time and space. Could end with * or some unique character in one space.

28. Runway ... in use, advise you have, could be deleted.

33. Nothing, too much information is not the problem, just how it is presented.

34. Don't overload information into ATIS message.

38. Words such as ATIS, AND, RWY and ADVISE SIERRA.

39. Misc. junk statements about birds/replying to hold shorts, etc.

48. Delete from voice system, (Good afternoon this is ...).

49. Routine NOTAMS.

51. Delete in use, VORTAC, extra words.

53. Excessive remarks.

13g) At the end of each ATIS is the reminder to "Advise you have information _____" (e.g., Foxtrot). Is it necessary to be reminded each time or is this an accepted routine procedure? Display space among other things might be saved if this could be deleted.

Yes	No
11	47

Comments:

1. Could be removed from the screen.

4. Delete "Advise" close with "INFO ALPHA" to signify closure/end of message.

5. Not necessary to be reminded.

11. Yes, if information was on ACARS only need it at the start.

12. Just state information, everyone knows they are supposed to report it.

14. Clearly note what the information is - accepted practice will fulfill the announcement requirement.

17. The ID lets both the pilot and controller know you have the current information. It can be shortened to "INFO we all know to advise the controller.

18. At times it is nice to have a reminder. Perhaps it could be shortened to "INFO FOXTROT".

20. Yes, crew doesn't have to memorize current info designator.

23. No, it's ingrained from the very first flight that is what you do.

25. No, as long as in header the name of ATIS is clear and easy to find, that should be sufficient.

29. Just put alpha code at end of message, i.e. "FOXTROT" or "F".

34. No, separate line - just use info letter, this will verify the end of ATIS information.

35. Yes, this comment signals the pilot has reached the end.

36. Yes, sometimes the ATIS is so long that you forget which info you have. Having it identified at the beginning and at the end would be a helpful reminder.

38. Not necessary - you are doing more than just providing me with information, you are telling me how to use it. Delete it and save space.

39. Not necessary - maybe just a repeat of the letter, or "ADVISE F", etc.

40. Yes, as long as each airfield has different reporting criteria.

46. Yes, desirable - easy to find quickly.

*U.S. GOVERNMENT PRINTING OFFICE: 1994-504-078-00037